CONFERENCE ON DISARMAMENT

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PROGRESS REPORT TO THE CONFERENCE ON DISARMAMENT ON THE THIRTY-SECOND SESSION OF THE AD HOC GROUP OF SCIENTIFIC EXPERTS TO CONSIDER INTERNATIONAL COOPERATIVE MEASURES TO DETECT AND IDENTIFY SEISMIC EVENTS

1. The Ad Hoc Group of Scientific Experts to Consider International Cooperative Measures to Detect and Identify Seismic Events, initially established in pursuance of the decision taken by the Conference of the Committee on Disarmament on 22 July 1976, held its thirty-second formal session from 29 July to 9 August 1991, in the Palais des Nations, Geneva, under the Chairmanship of Dr. Ola Dahlman of Sweden. This was the twenty-fourth session of the Group convened under its new mandate by the decision of the Committee on Disarmament at its 48th meeting on 7 August 1979.

2. The Ad Hoc Group continues to be open to all member States of the Conference on Disarmament, as well as upon request to non-member States. Accordingly, scientific experts and representatives of the following member States of the Conference on Disarmament participated in the session: Australia, Belgium, Canada, China, Czech and Slovak Federal Republic, Egypt, Germany, Hungary, Indonesia, Iran (Islamic Republic of), Italy, Japan, Netherlands, Pakistan, Peru, Poland, Romania, Sweden, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland and the United States of America.

3. At their request and on the basis of previous invitations by the Conference on Disarmament, scientific experts and representatives from the following non-member States of the Conference on Disarmament participated in the session: Austria, Denmark, Finland, New Zealand, Norway, Spain and Switzerland.

4. Two representatives of the World Meteorological Organization (WMO) also attended the session. The Ad Hoc Group expressed its appreciation of the efforts of the WMO in connection with the GSETT-2 experiment. The Group is prepared to continue its cooperation with the WMO in order to take advantage of the possibilities offered by its Global Telecommunication System.

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5. Upon the invitation of the Conference on Disarmament, a representative of the International Maritime Satellite Organization (INMARSAT) attended the session of the group to discuss possibilities for the use of INMARSAT in the development of the communications aspect of a future global seismic data exchange system. The Ad Hoc Group highly appreciated the presentation and technical demonstration given by the representative of INMARSAT on its high speed data communication possibilities. INMARSAT mobile earth stations could provide data communication from regions of the globe that currently are not adequately served by existing communication systems. The INMARSAT representative noted that the INMARSAT system is open for immediate use by the Group, subject to the regulations in the countries in which the earth stations are to be placed. No formal decision needs to be taken by INMARSAT in this regard. The Group also received a report on the successful initial use of the INMARSAT system for the exchange of Level I and Level II seismic data during GSETT-2.

6. Under the current mandate of the Ad Hoc Group, information on national investigations related to the work of the Group has been presented by experts from Australia, Austria, Belgium, Bulgaria, Canada, China, Czech and Slovak Federal Republic, Denmark, Egypt, Finland, Germany, Hungary, India, Indonesia, Iran (Islamic Republic of), Italy, Japan, Kenya, Netherlands, New Zealand, Norway, Pakistan, Peru, Poland, Romania, Spain, Sweden, Switzerland, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, United States of America and Zambia.

7. In 1987, the Ad Hoc Group agreed to conduct a large-scale international experiment on the exchange and analysis of seismic waveform (Level II) and parameter (Level I) data. The experiment was named GSETT-2 (the Group of Scientific Experts' Second Technical Test). The principal purpose of GSETT-2 was to test methods and procedures developed by the Ad hoc Group to expeditiously extract and transmit the data from stations to Experimental International Data Centers (EIDCs), to process them at EIDCs and to transmit the results back to participants.

8. The Ad Hoc Group reviewed the results of the full-scale phase of GSETT-2, which was successfully conducted during the period 22 April to 9 June 1991. The Group noted that 34 countries participated in this test, providing seismic data for 42 consecutive data days from 60 stations distributed around the globe. During this time, the participating countries operated National Data Centers (NDCs), some with assistance from other countries. Four Experimental International Data Centers (EIDCs) were operated, and a variety of international communication links were utilized.

9. The Ad Hoc Group noted with satisfaction that the participation in the full-scale test was broadened compared to earlier preparatory tests. In particular the Group welcomed the participation of several additional countries in South America and Africa, which implied an improvement in obtaining seismological observations in these regions. The Group noted that significant technical cooperation took place among many countries, and expressed its appreciation for the efforts in supporting the participation of new countries.

10. In reviewing the results of GSETT-2, the Ad Hoc Group noted that many of the components of the experimental global system had functioned well, taking into account the size and complexity of this undertaking. The procedures and instructions were generally followed. Valuable experience was gained at both national and international centres. This test was a large and in many ways unprecedented undertaking because of the complexity of the system, especially the communications links used, and the expeditious nature of daily seismic event bulletin preparation and exchange.

11. The large-scale experiment could not have been successfully conducted without preparation of detailed instructions, acquisition of necessary equipment and adequate preparatory testing. The Ad Hoc Group expressed its appreciation of the efforts of the Coordinator of GSETT-2, Mr. Peter Basham of Canada. The Group also expressed its appreciation to the Coordinator of the "Sourcebook for Seismic Data Exchange", Ms. Ann Kerr of the United States, for her efforts in preparing this comprehensive reference manual.

12. The Group noted that as a result of GSETT-2, a unique seismological database has been established. These data will be of great value for future scientific investigations in many areas.

13. The Group noted that a comprehensive evaluation of the results from GSETT-2 will be a substantial undertaking. The Group noted that an important aspect of the evaluation would be to refine the concepts of a global system as described in the Group's Fifth Report (CD/903 and Corr.1). At its thirty-first session, the Ad Hoc Group established five study groups, each headed by a Convenor, to deal with different aspects of this work. The Group reviewed initial draft outlines of chapters of its envisaged report, elaborated by the Convenors.

14. A summary report on the preliminary results of the test, compiled by the Convenors of the five study groups, is annexed to this progress report.

15. The Group agreed that the Convenors should elaborate complete draft chapters and submit them to the Scientific Secretary in advance of the next session. These will form a basis for a draft report which will be distributed in advance of and reviewed during the next session.

16. The Group will make all effort to complete a report on a comprehensive evaluation of the technical and factual aspects of the test during the spring session of 1992. While it may be possible to summarize the technical conclusions from GSETT-2 during the next session of the Group, the full seismological evaluation will need considerably more time, and will be reported on later. In this regard, the Group believes it will be important to carry out additional checking of the procedures which will be used in the evaluation of GSETT-2. It will be desirable to have facilities available that would provide for taking part in tests that may be required for the successful evaluation of GSETT-2. The Group will again consider this issue at the next session.

17. The Ad Hoc Group continued its preliminary discussion on the work of the Group remaining under its current mandate as regards international cooperative measures to detect and identify seismic events. The Group expressed the view that much valuable work could be conducted in this context. The Group expects to be able to develop specific recommendations in this regard during its next session, taking into account the results of GSETT-2.

18. The Ad Hoc Group appreciated the opportunity to attend informal technical presentations made by Canada on new methodologies in seismic verification, and by Germany on the concept of an open CD-seismic station.

19. The Ad Hoc Group suggests that its next session, subject to approval by the Conference on Disarmament, should be convened from 2 to 13 March 1992.

ANNEX

Summary report on the preliminary results of the Group of Scientific Experts' Second Technical Test (GSETT-2)*

1. Introduction

In 1987, the Ad Hoc Group of Scientific Experts (the GSE) agreed to conduct a large-scale international experiment on the exchange and analysis of seismic data. The experiment was named GSETT-2 (the Group of Scientific Experts' Second Technical Test). In the document CD/745 the Group stated that:

"The principal purpose of this experiment should be the testing of methods and procedures developed by the Ad Hoc Group to expeditiously extract and transmit the data from stations to Experimental International Data Centers (EIDCs), to process them at EIDCs and to transmit the results back to participants."

The Group's Fifth Report (CD/903 and Corr. 1) describes the initial design concepts of a modern international seismic monitoring system. These technical concepts which were to be tested during GSETT-2, are based on expeditious exchange of waveform (Level II) and parameter (Level I) data and processing of such data at International Data Centers (IDCs). The proposed system consists of four major elements:

(i) A global network of high-quality seismograph stations, including seismic arrays, each conforming to specified technical standards and operated according to internationally agreed rules.

(ii) Government-authorized National Data Centers (NDCs) responsible for providing agreed seismic data from national stations to IDCs.

(iii) International Data Centers to collect and analyse seismic waveform and parameter data, to distribute the results of these analyses and to make the data readily accessible to all participants.

(iv) Telecommunications channels for the expeditious exchange of data between NDCs and IDCs, as well as among IDCs.

In its progress reports to the Conference on Disarmament, the Ad Hoc Group has described the various stages in the planning and development of GSETT-2. In addition, two internal documents (Conference Room Papers 167 and 190) contain comprehensive descriptions of the experimental facilities being developed and the procedural arrangements. Mr. Peter Basham of Canada has served as the Coordinator of GSETT-2.

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* Compiled by the Convenors of the five study groups.

GSETT-2 is comprised of four distinct phases:

Phase 1: Establishing the facilities and procedures that would form parts of the experimental system to be tested;

Phase 2: Limited short-time tests of the experimental system, in preparation for full-scale testing;

Phase 3: (The main phase of GSETT-2): Full-scale testing, for 42 consecutive data days, of the entire experimental system;

Phase 4: Evaluation of the results of GSETT-2.

The experiences during Phase I and Phase II of GSETT-2 and the preparatory test (November-December 1991) of Phase 3 were essential for the successful conduct of the full-scale test (Phase 3).

This initial evaluation report summarizes the results of the main phase (Phase 3), which was conducted during the time period 22 April-9 June 1991.

2. Seismograph Stations and Station Network

There are two types of seismograph stations available which may be combined in an appropriate way to form a global network. One is the single-site three-component seismograph system capable of extracting data in both the short period and long period bands, and the other is a seismic array station where many seismographs are arranged in a certain geometrical pattern and jointly operated.

In Phase 3 of the GSETT-2 experiment 34 countries took part with altogether 60 stations (12 arrays and 48 single-site stations). Most of the stations were high quality digital recording systems providing both Level I and Level II data. Stations with analog recording systems were also used in a few cases. While these stations provided only Level I data, they served to improve the geographical coverage. Various designs of "CD-standard stations" were tested during the experiment.

The station network in use during the full-scale test comprised stations on all continents. Still, the actual geographical distribution of stations was far from ideal, with a very dense coverage in parts of Europe and sparse coverage especially in Africa and South America.

The initial evaluation of GSETT-2 has confirmed the importance of deploying seismograph stations at sites with low background noise levels. Stations situated on islands and in coastal areas generally contributed far less than sensitive stations in the interior of continents, but they were important in some cases.

GSETT-2 has confirmed the importance of array stations in detecting weak seismic events at all distances, and in providing initial event location information. Modern three-component stations were also found to be valuable.

It can be concluded that modern technology and recent scientific developments permit high flexibility in station deployment and lower operation and maintenance costs. All of these features, as well as the increased efficiency and reliability of station hardware and software, were demonstrated in the course of GSETT-2.

3. National Data Centers (NDCs)

During the full-scale test 34 countries successfully operated national data centres (NDCs), some with assistance from other countries. Thus there were several countries which under bilateral arrangements either operated an NDC for another country or performed one or more of the NDC functions (e.g. Level I data extraction, GSE message formating, etc.) for another country. This test was a large undertaking. More than 100 people were involved at NDCs during Phase 3. NDCs reported over 100,000 parameters with their associated waveforms to EIDCs. These data were contained in over 20,000 messages and amounted to about 500 Mbytes. In a new and unique contribution, NDCs reported about 5,000 locations of seismic events based on only national data.

In order to accomplish this tremendous task, many NDCs operated automatic seismic event detectors and utilized state-of-the-art computer hardware and software to perform interactively many of the NDC functions, such as parameter and waveform data extraction. In addition, some countries were able to utilize semi-automatic procedures for handling GSE messages including responding to requests for additional data. It should be noted that a number of countries were able to participate in the full-scale test with only limited data reporting. Reasons for this included limited funds, relatively poor station availability, etc.

Nevertheless, a valuable database has been assembled which will be available for the comprehensive evaluation (Phase 4) of GSETT-2.

Although preliminary indications are that procedures and instructions for operating NDCs generally worked well, it is clear that some modifications are needed. It will be necessary to work further towards developing common procedures for automatic and interactive analysis at NDCs.

Most NDCs successfully received all Final Event Bulletins (FEBs) from the EIDCs; however, these were generally one or two days later than the planned seven-day schedule, with a few cases of fifteen days or more late. Some NDCs did not receive all FEBs. Many NDCs made preliminary analyses of the FEBs which suggested that some procedures, such as automatic association and location need to be improved.

The GSETT-2 provided the first opportunity to test the procedures for requests to NDCs for additional data. While some NDCs were able to respond completely and quickly, problems in this area remain.

4. Experimental International Data Centers (EIDCs)

Four Experimental International Data Centers (EIDCs) were operated during Phase 3 of GSETT-2: Canberra (CNB), Moscow (MOS), Stockholm (STO) and Washington (WAS). High-speed communication links were implemented between the four EIDCs.

A total of about 65,000 phase detections were reported from 57 stations in 34 countries. Twenty-seven (27) countries submitted a total of more than 80,000 waveform segments (Level II data) recorded at 47 stations. Less than 2 per cent of a total of 36,000 messages contained format errors, and roughly 20 per cent of the 65,000 phase detections arrived late (i.e. after the deadline according to the rules). More than 3,000 duplicate messages (several hundred megabytes) were received by the EIDCs.

The daily volumes during Phase 3 had increased by a factor of two compared to earlier experiments of GSETT-2. This was partly due to more local and regional phases reported by many NDCs compared to earlier. These additional phases also partly explain why more than 50 per cent of the reported phases could not be associated to an event. The EIDCs have received and transmitted requests from and to both NDCs and other EIDCs. Some EIDCs satisfied most of the incoming requests and transmitted their response in time while others encountered problems due to software difficulties, lack of fully automatic request handling programmes and insufficient manpower.

The importance of an EIDC's ability to request supplemental data is demonstrated by the fact that, for instance, several hundred new phases with observable signals were picked by the EIDCs from examination of waveform segments received in response to requests.

The use of waveforms improved the quality of the event lists considerably, in particular the depth estimation was improved. However, further investigation is necessary to make an accurate assessment. The reconciliation of the seismic analysis between the EIDCs was done through a regular (i.e. daily) exchange of IELs and CELs. Approximately 40 per cent of the events in the FEBs were reported by all four EIDCs and 60 per cent by at least three EIDCs. The fact that the results of the EIDCs were not essentially identical will be subject to further evaluation studies.

The locations and comments supplied in addition to the phase reports by the NDCs were not used to the extent expected.

As a preliminary conclusion, it may be stated that the overall performance of many of the EIDC procedures were satisfactory. Adequate improvements of the applied rules and procedures will be recommended after completion of the already started detailed evaluation of the EIDC performances during GSETT-2.

5. Communications

The overall impression from Phase 3 of GSETT-2 is that the communications network, comprising NDC to EIDC as well as inter-EIDC links, worked very well. The network in place for Phase 3 was composed of a large variety of types of physical links, and a range of different protocols were utilized. With a few exceptions, the elements of this network fulfilled the basic objective of enabling expeditious exchange of large amounts of seismic data and other messages.

Problems encountered with the use of NDC to EIDC links were very few. It became apparent, however, that use of WMO/GTS for transmission of large volumes of data (such as waveform data and FEBs) met with a moderate degree of success only. For several countries, however, the WMO/GTS represented the only means for transmission of seismic data and in general proved useful for reporting parameter data.

Many countries made use of the international Packet-Switched Data Network Services, and a number of NDCs established direct computer-to-computer links via dial-up circuits. Experience with such links was very favourable. Some countries established alternative routings that were used successfully during outages of their "main" communications link. The INMARSAT system for exchanging Level I and Level II data was tested for the first time.

The inter-EIDC communications network comprised high speed dedicated satellite, fibre optical and land links between the four EIDCs, the Washington Communications HUB and the Stockholm Communications Node. After the installation of the satellite link between Moscow and Washington on 29 April, the inter-EIDC communications network worked extremely well, taking into account the complexity of the system and the large amount of data handled. There were some problems related to the generation of duplicate messages, but it is expected that only minor modifications are needed to remedy this problem.

6. Seismological Evaluation

An important aspect of the performance of a global seismological monitoring system is the completeness and quality of the final event bulletin (FEB). This seismological output is closely linked to the adequacy of the technical components of the monitoring system, it especially depends on the spatial distribution of seismic stations. For GSETT-2, a very heterogeneous global coverage yielded large regional variations in detection threshold and a large number of unassociated single station detections. About one half of the participating stations were situated in and around Europe, consequently a large number of small events were detected, mainly quarry blasts and rock bursts of magnitude 1 to 4.

On the other hand, epicentres of larger earthquakes reported in the FEBs are not restrained by well-known plate boundaries but show a significant scatter. This observation leads to the conclusion that the FEBs, in general, have to be re-evaluated without the time pressure given during the experiment, before a comprehensive seismological evaluation can begin.

This evaluation will compare the EIDC epicentres, hypocentres, and magnitudes with results of well-established agencies on a global scale (e.g. National Earthquake Information Center in the United States) and for specific regions like Europe (European Mediterranean Seismic Centre).

In addition, the unique data set collected during GSETT-2 should be evaluated in all aspects which are relevant to the identification of seismic sources. This topic - although of crucial importance for States in their national monitoring of compliance with a nuclear test-ban treaty - has not yet been addressed by the GSE. For the first time, there is now, through GSETT-2 data, a common basis to start this investigation. While it may be possible to summarize the technical conclusions from GSETT-2 during the next session of the Group, the full seismological evaluation will need considerably more time, and will be reported on later.